Automated Demand Response in Large Commercial Facilities

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drrc.lbl.gov

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Presentation Overview

- ❑ Automated Demand Response Executive Summary
- ❑ California Price-Responsive DR Goals
- ❑ Methods and Results from Auto-DR Research
- ❑ Next Steps and Future Directions
- ❑ Overview of DR Research Center

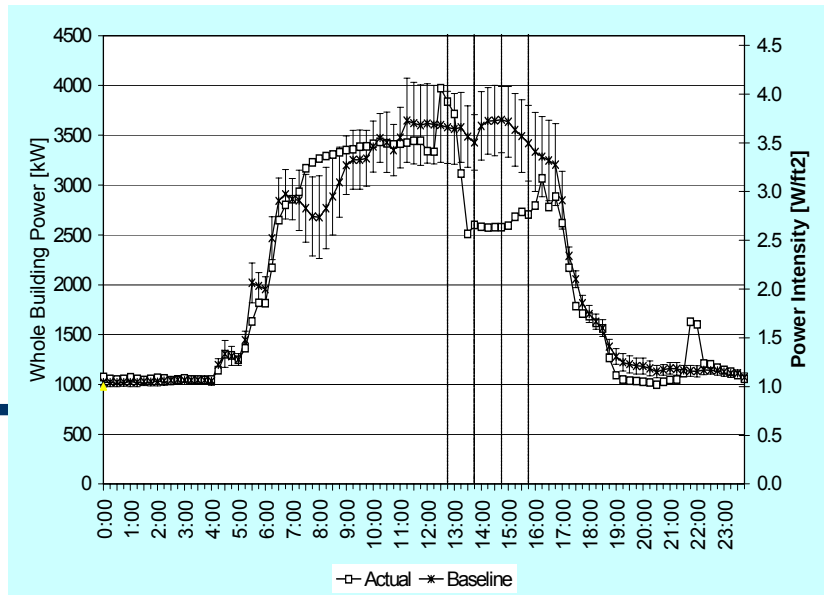
Auto-DR - What is it ?

- Provide large (>200kW) customers with electronic, Internet-based price and reliability signals
- Automatically link price and reliability signals into the facility control systems
- Customer's program automated response customized to facility and client / tenant needs
- Develop facility response strategies that 'optimize' load reduction, economic savings and customer acceptance

Auto-DR - Results

❑ Significant peak load (kW) reductions (22 sites)	Average 10%
❑ 3 to 6 hour DR events	Greater potential for shorter events
❑ Setup-commissioning based energy (kWh) savings	Still being Assessed
❑ High customer acceptance	Persistent savings

Oakland Federal Building: ~800 kW, Savings 20%



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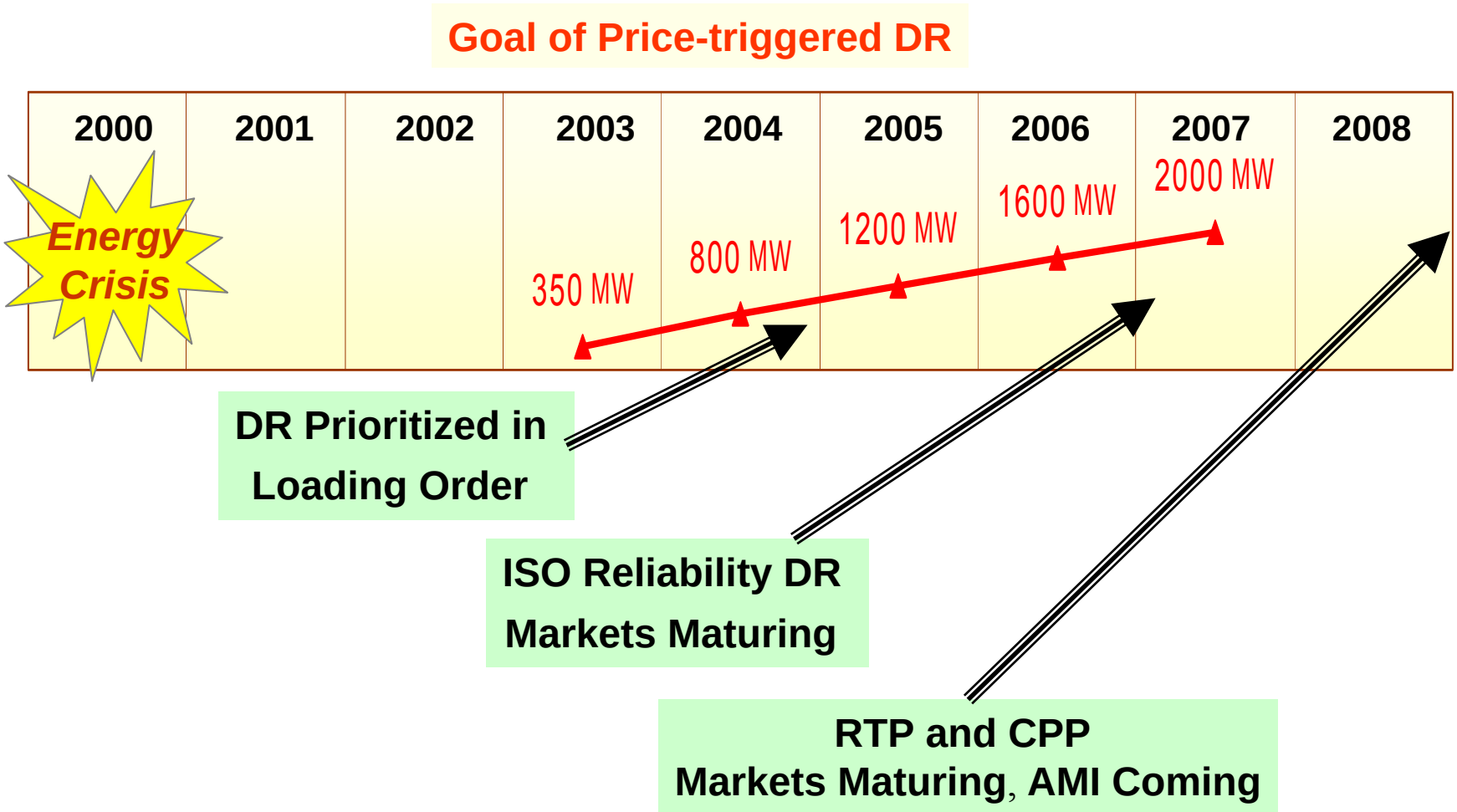
Auto-DR Results with Economics

Company	Avg kW Savings	Avg % Savings	Max kW Saving	# of events *2005 (2003-2004)*	Total Setup Cost	$/kW
ACWD	52	20%	84	4 (0)	$12,824	$153
B of A	111	2%	227	3 (4)	$1,614	$7
Chabot	18	5%	46	3 (1)	$4,510	$97
50 Douglas	61	21%	85	4 (4)	$2,000	$24
2530 Arnold	61	16%	92	1 (3)	$2,000	$22
Echelon	78	25%	110	4 (3)	$3,620	$33
Gilead	71	10%	208	4 (1)	$7,500	$36
IKEA	219	12%	272	2 (0)	$5,050	$19
Oracle	45	10%	65	1 (0)	$375	$6
Target	33	10%	56	4 (1)	$3,312	$60
USPS	202	15%	265	0 (2)	$12,000	$45

Why Auto-DR ?

- California has a peak load problem
- Large commercial / industrial customers have AMI, TOU rates and CPP options
- Large commercial customers need well defined response
- Prior DR response problematic
  - Labor intensive and costly
  - Requires “someone to respond”
  - Uncertain from one event to another

Demand Response in California

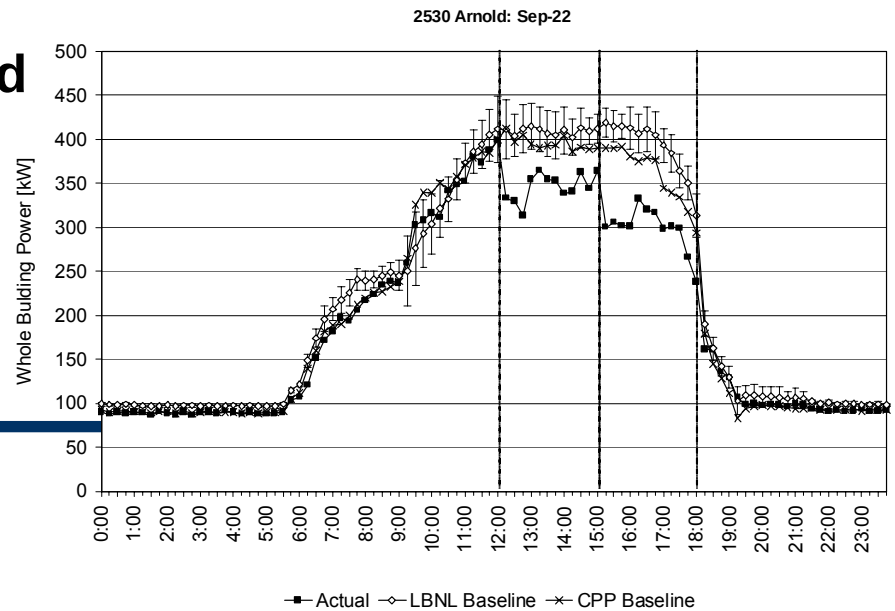


Methodology

- Develop Demand Response Automation Server (annually updated)
- Develop connection to Energy Management Control Systems (EMCS)
- Field Tests – Recruit sites/ 2 to 12 events per summer
  - 2003 - 5 sites – Internet link to Energy Information Systems (EIS)
  - 2004 – 18 sites - linked to EIS and EMCS
  - 2005 - PG&E CPP collaboration
  - 2006 - PG&E, SDG&E, Planning with SCE

Evaluate with weather normalized 10 day baseline

Interview site after each event



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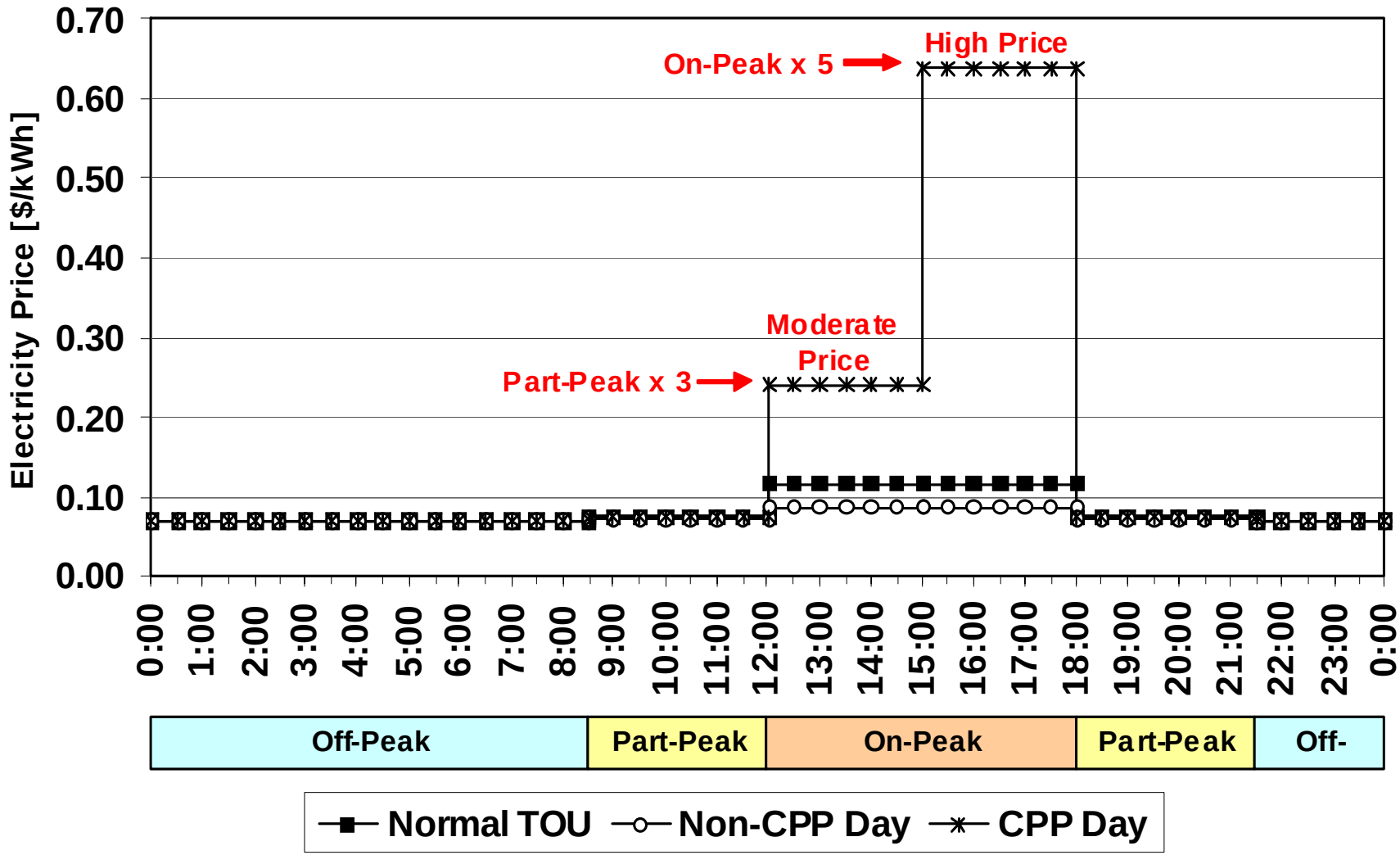
PG&E's 12-day/yr Critical Peak Price



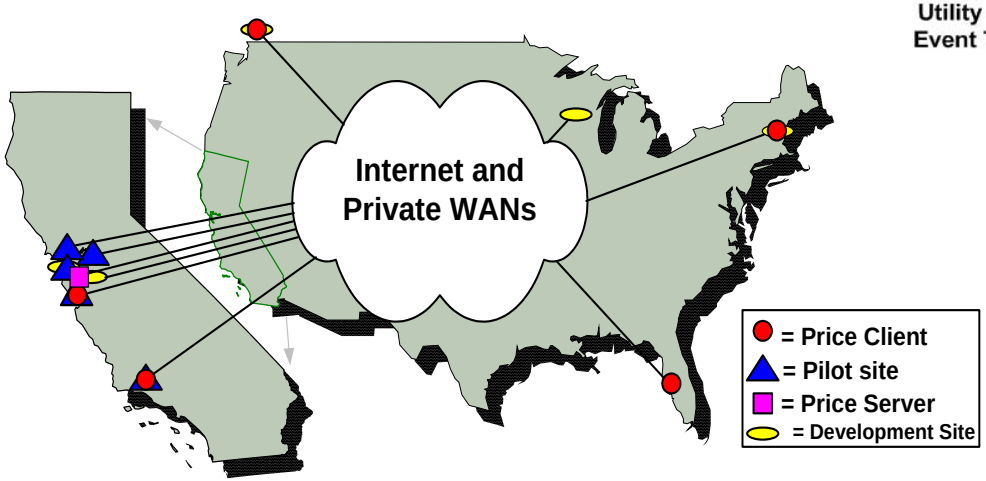
DR Automation Server

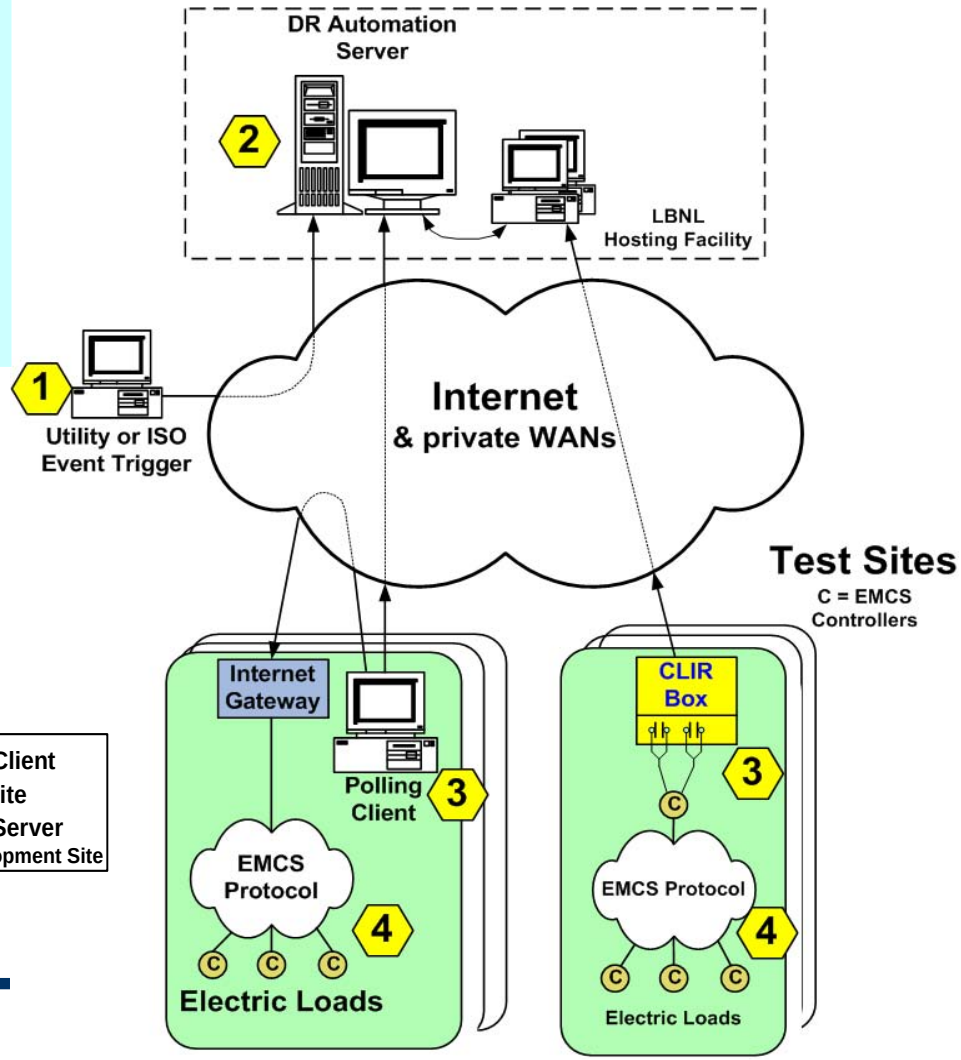
1 - PG&E CPP defines price schedule

2 - Price published on DR Automation Server

3- Clients request price from server every minute and send shed commands

4- EMCS carries out shed automatically





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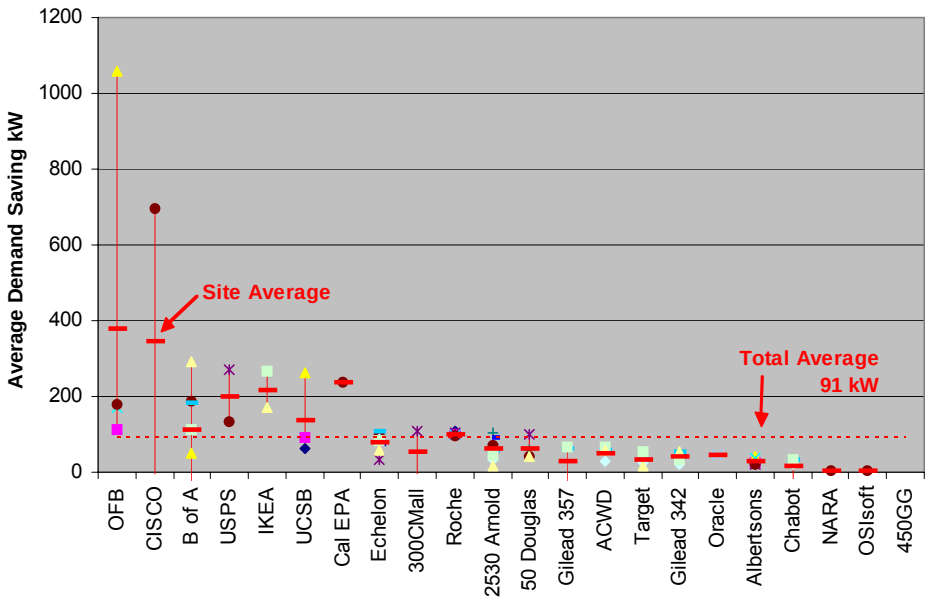
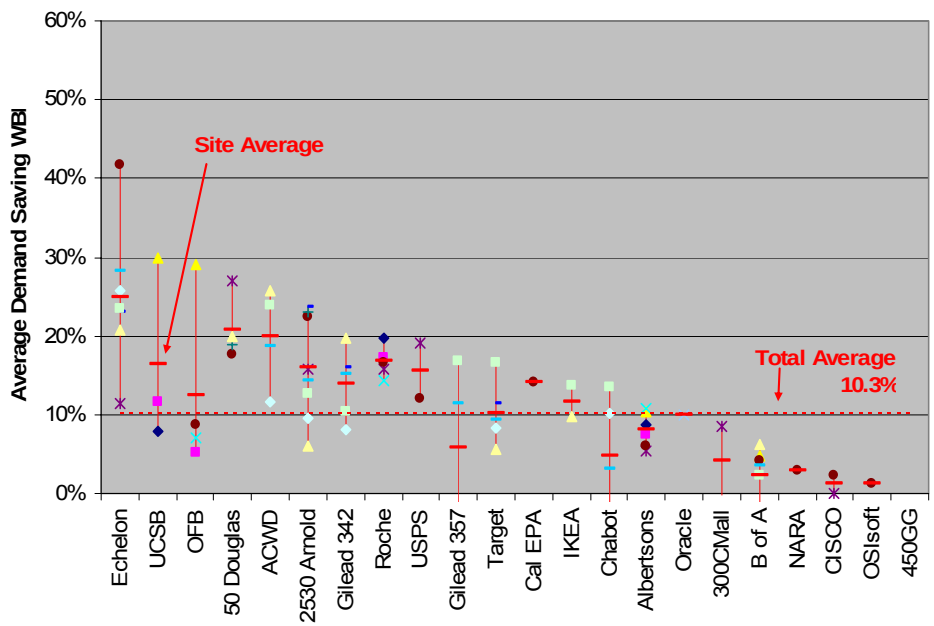
Results by Site

- 22 sites evaluated over 3 years
- Multiple building types, control strategies, and climates
  - Avg savings: 10% (3 hr event, 22 sites, 13 events); avg 15-min max: 19 %
  - Avg savings: 91 kW, avg max of 170
  - Avg savings: 0.5 W/sqft, avg max of 0.9 W/sqft





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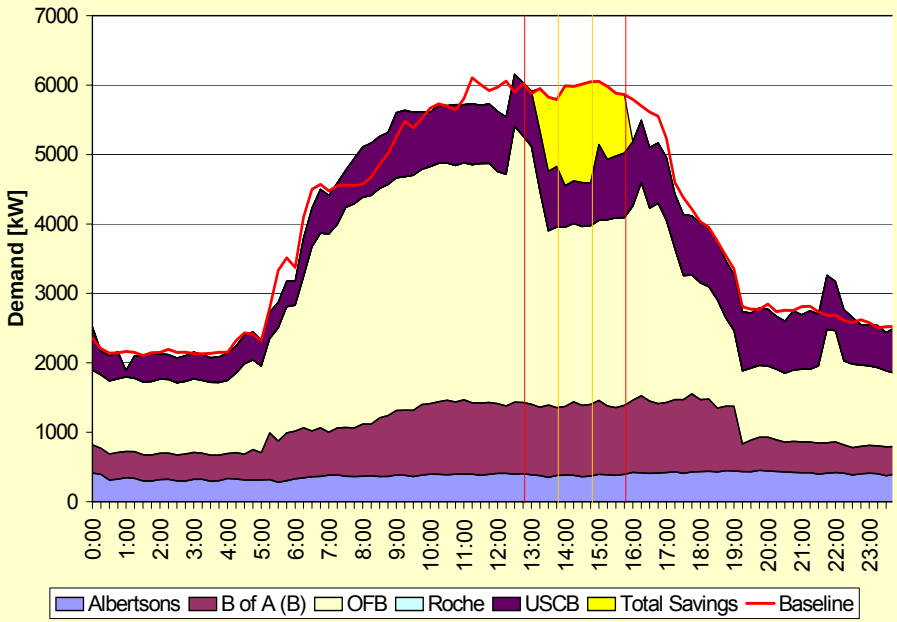
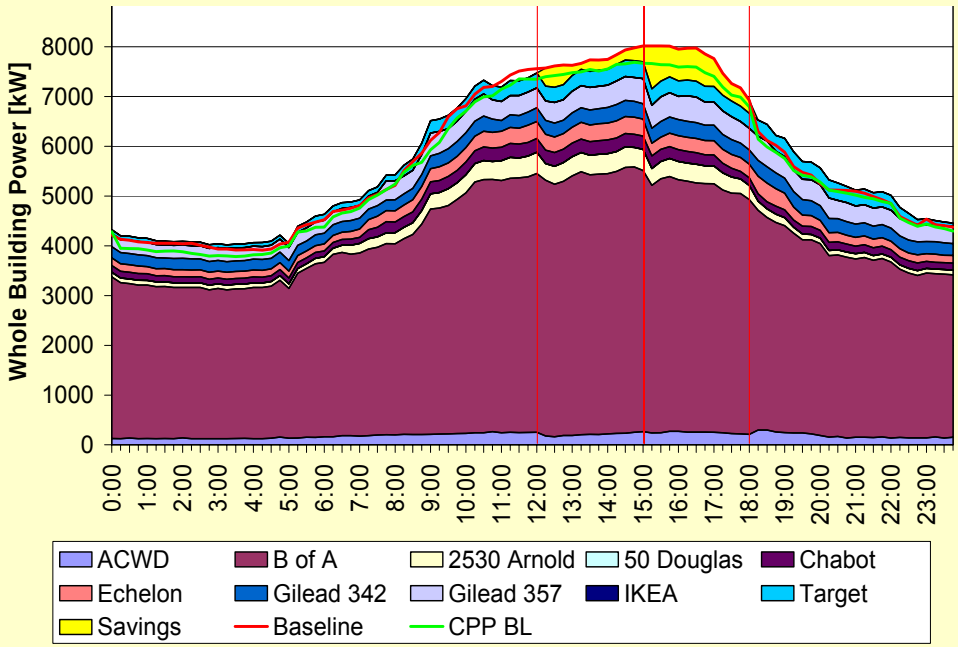
Aggregated Results

2004 Hot Weather Test: 5 sites



2005 Auto-CPP Test: 10 sites



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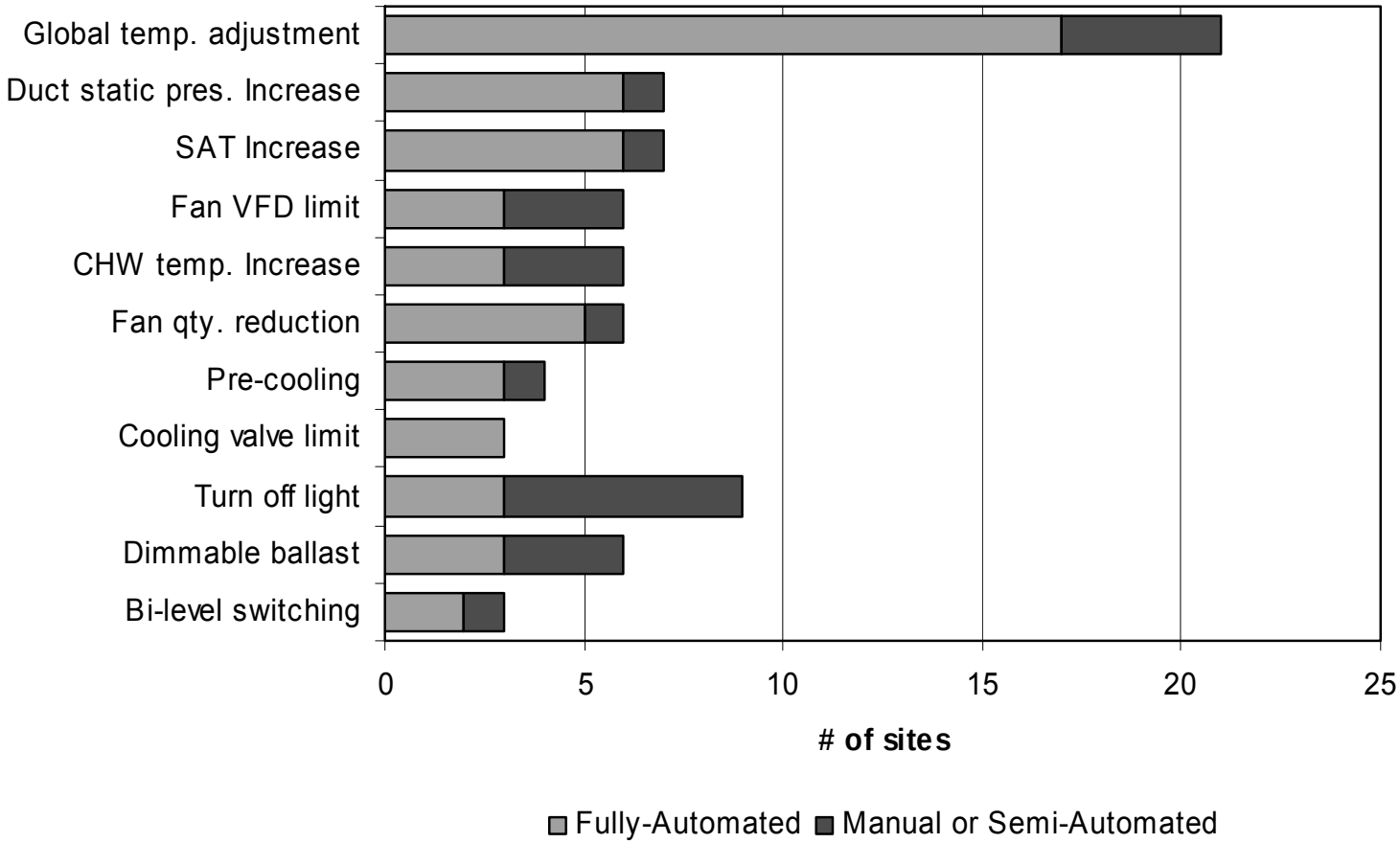
Building Name, Type, and Strategies

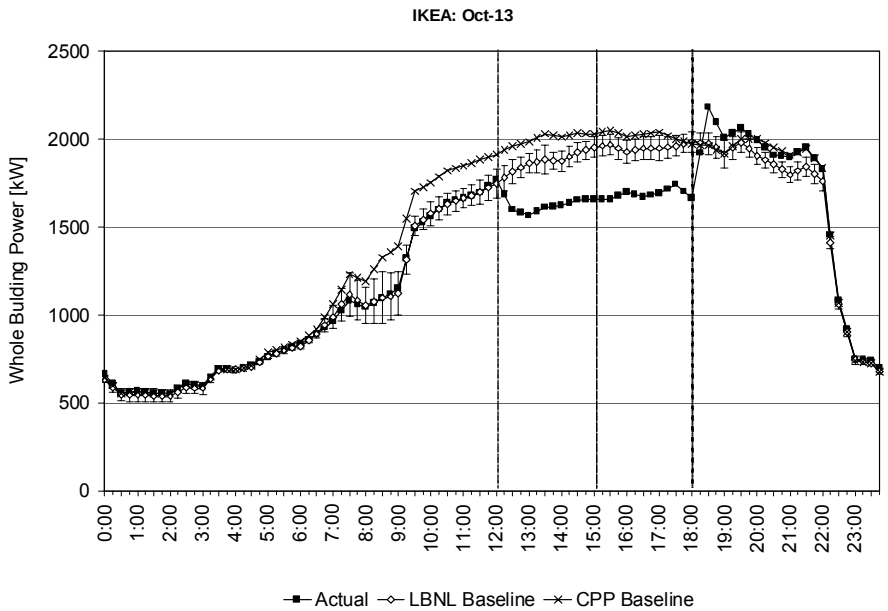
		Participation				HVAC													Light, Misc.						
		CA-2003	CA-2004	CA-2005	NY	Global temp. adjustment	Fan-coil unit off	SAT reset	Fan VFD limit	Duct static pres. reset	Fan quantity reduction	Electric humidifier off	CHW temp. reset	CHW current limit	Chiller demand limit	Boiler lockout	Pre-cooling	Extended shed period	Slow recovery	Common area light dim	Office area light dim	Elevator cycling	Anti-sweat heater shed	Fountain pump off	Transfer pump off	Rock crashers off
300 CapMall	**Office**		●			X			X		X		X											X		
ACWD	**Office**			●		X		X		X			X	X		X		X								
Albertsons	**Supermarket**	●																	X			X				
B of A	**Office**	●	●	●				X	X	X			X	X												
Chabot Museum	**Museum**			●		X											X									
Cal EPA	**Office**		●							X									X	X						
CETC	**Office**		●								X	X														
Cisco	**Office/Data**		●			X	X									X			X	X						
2530 Arnold	**Office**		●	●		X												X								
50 Douglas	**Office**		●	●		X												X								
Echelon	**Office**		●	●		X		X		X	X								X	X						
GSA 450 GG	**Office**		●			X																				
GSA NARA	**Archives**		●			X																				
GSA Oakland	**Office**	●	●			X																				
Gilead 300	**Office/Lab**			●				X																		
Gilead 342	**Office/Lab**			●		X		X																		
Gilead 357	**Office/Lab**			●		X		X																		
Home Depot	**Retail**				●														X							
Irvington	**High School**			●		X											X									
IKEA	**Retail**			●		X																				
Kadent	**Industry**		●																						X	
Lafarge	**Industry**				●																					X
LBNL OSF	**Office/Data**			●		X											X									
Monterey	**Office**		●																X							
NY Times	**Office**				●	X	X	X									X		X	X						
Oracle	**Office**			●		X				X																
OSIsoft	**Office**		●			X																				
Roche	**Office/Cafeteria**	●	●								X															
Rockefeller Center	**Office**				●				X				X								X					
Target	**Retail**			●							X								X							
UCSB Library	**Library**	●	●						X	X				X												
USPS	**Postal**		●	●											X			X								

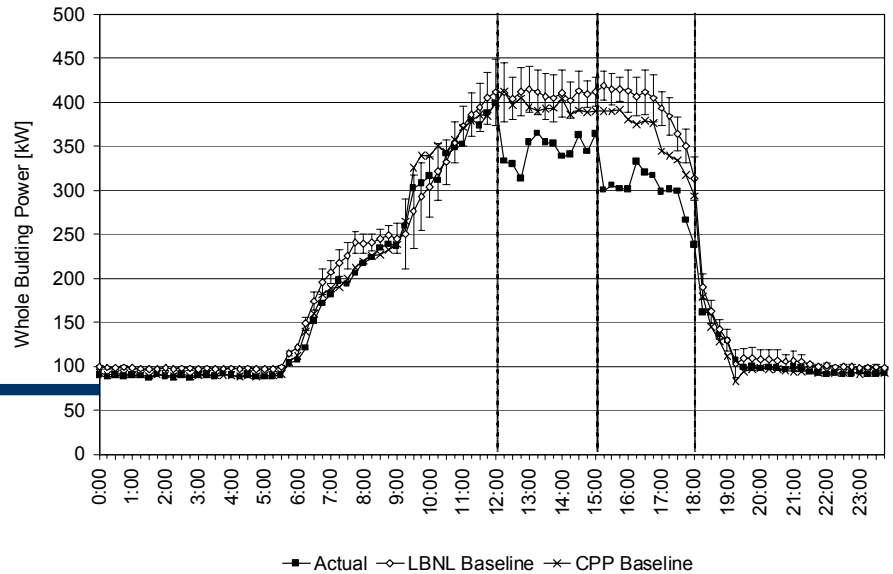
Strategies Used and Factors Influencing Savings



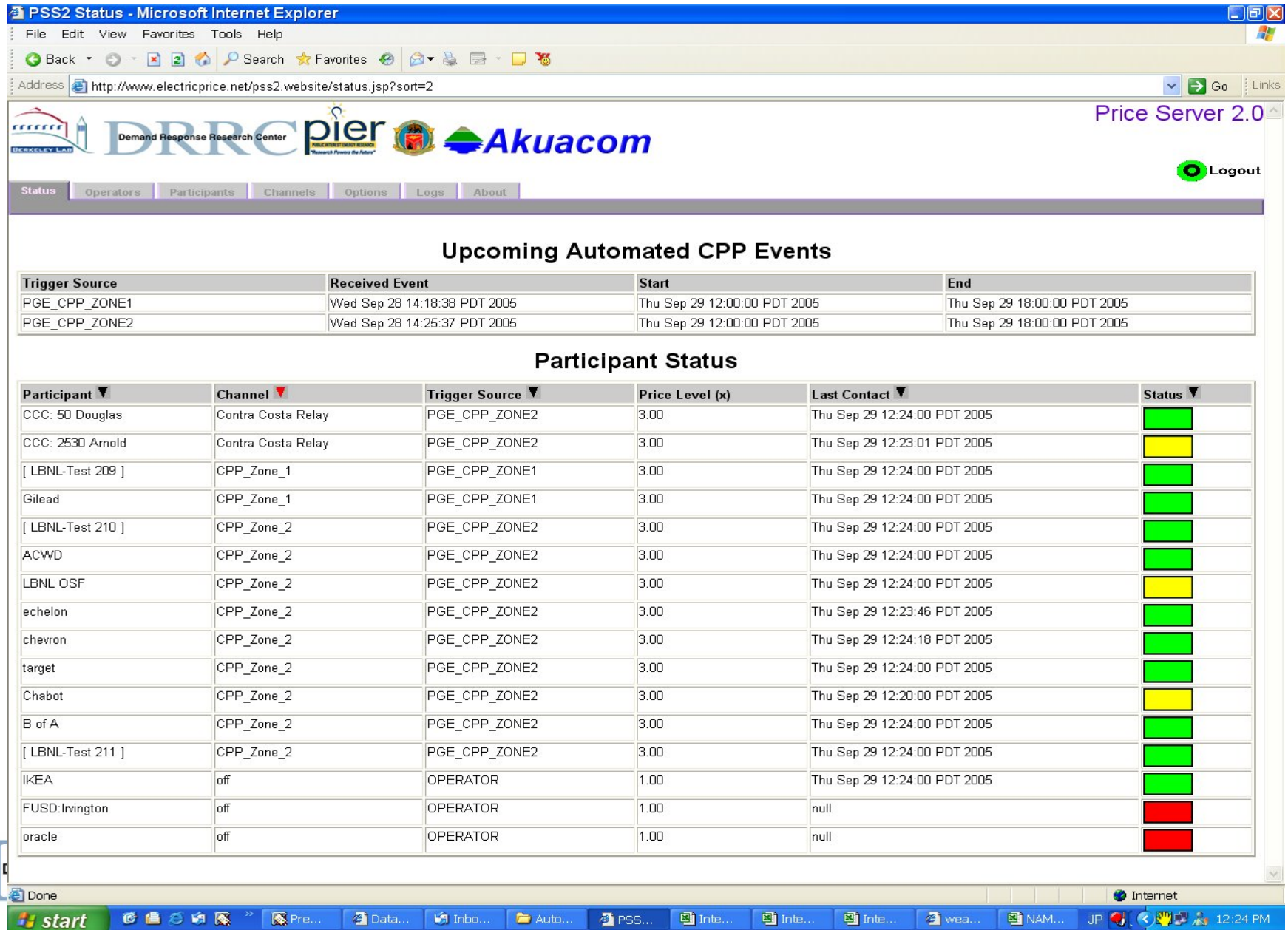
Building factors	System factors	Strategy factors	Weather factors
▪ Building use ▪ Building size ▪ Structure type ▪ Occupancy	▪ HVAC type ▪ Efficiency ▪ Control type ▪ Commissioning	▪ Depth of control ▪ Area% controlled ▪ Curtailment duration	▪ Outside Temp ▪ Humidity ▪ Solar radiation

Sample Individual Building Results





DR Automation Server



Upcoming Automated CPP Events

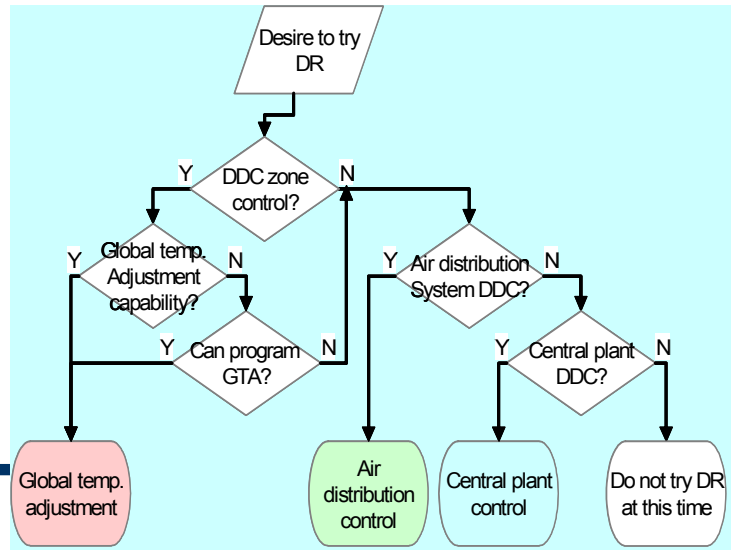
Trigger Source	Received Event	Start	End
PGE_CPP_ZONE1	Wed Sep 28 14:18:38 PDT 2005	Thu Sep 29 12:00:00 PDT 2005	Thu Sep 29 18:00:00 PDT 2005
PGE_CPP_ZONE2	Wed Sep 28 14:25:37 PDT 2005	Thu Sep 29 12:00:00 PDT 2005	Thu Sep 29 18:00:00 PDT 2005

Participant Status

Participant	Channel	Trigger Source	Price Level (x)	Last Contact	Status
CCC: 50 Douglas	Contra Costa Relay	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
CCC: 2530 Arnold	Contra Costa Relay	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:23:01 PDT 2005	
[LBNL-Test 209]	CPP_Zone_1	PGE_CPP_ZONE1	3.00	Thu Sep 29 12:24:00 PDT 2005	
Gilead	CPP_Zone_1	PGE_CPP_ZONE1	3.00	Thu Sep 29 12:24:00 PDT 2005	
[LBNL-Test 210]	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
ACWD	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
LBNL OSF	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
echelon	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:23:46 PDT 2005	
chevron	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:18 PDT 2005	
target	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
Chabot	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:20:00 PDT 2005	
B of A	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
[LBNL-Test 211]	CPP_Zone_2	PGE_CPP_ZONE2	3.00	Thu Sep 29 12:24:00 PDT 2005	
IKEA	off	OPERATOR	1.00	Thu Sep 29 12:24:00 PDT 2005	
FUSD:Irvington	off	OPERATOR	1.00	null	
oracle	off	OPERATOR	1.00	null	

Linking DR with Energy Efficiency

- **Ideal start -** good commissioning, retro-commissioning, advanced/new controls
  - **HVAC -** Direct digital control (DDC) global temperature adjustment
    - In process for Title 24 2008
    - Closed loop
  - **Lighting Continuum** - Zone Switching, Fixture Switching, Lamp Switching, Stepped Dimming, Continuous Dimming
  - **Maybe you "can" use a strategy every day?**



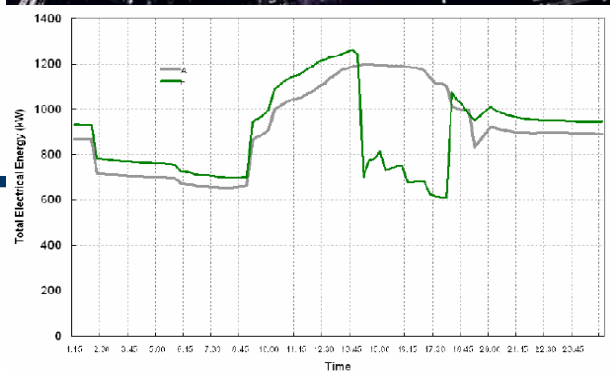
Future New Buildings & NY Times

- **Technology designed for efficiency simulated to develop DR strategies**
  - Efficient features: Integrated movable, Shading & dimming, Under floor air systems
  - Commissioning in mockup

- **Demand Response Strategies**
  - Dimming lights beyond daylighting,
  - Reset zone temperatures (gradient)
  - Reduce perimeter fan speed

Predicted Annual Savings from 400 kW Shed

Program	Predicted Annual Savings*
Independent Capacity Program	$17,632.00
Emergency DR Program	$1,440.00
Distribution Load Relief Program	$1,600.00



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Summary and Future

Key Findings

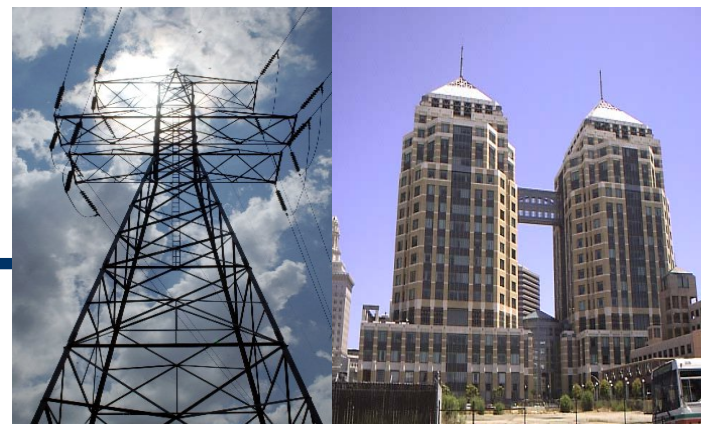
- Auto-DR is technically feasible with minor enhancements to technology
- Avg reduction of 10 % over 22 sites
- Many facilities support the objectives of DR (repeat customers!)

Future Directions

- Additional research on the costs and benefits of Auto-DR
- Advanced controls provide even greater opportunity for efficiency & DR
- Excellent opportunities to standardize signaling between utilities and ISO
- Embed into EMCS and integrate in code in future
- Real time continuous link of Supply and Demand!

See drrc.lbl.gov for publications

Come see demo!



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DRRC Overview

Objective

to develop, prioritize, conduct, and disseminate multi-institutional research to facilitate DR

Scope

technologies, policies, programs, strategies and practices, emphasizing a market connection

Method

Partners Planning Committee, Annual R&D Plan

Stakeholders

- State Policy Makers
- Researchers
- Information and Metering System Developers
- Aggregators
- Program Implementers
- Utilities
- Industry Trade Associations
- Building Owners / Operators
- Building Equipment Manufacturers
- End-Use customers

Existing Projects

Completed and In Process

- **Project 1** — Evaluation of RTP for Large Users
- **Project 2** — Demand Shifting with Building Thermal Mass
- **Project 3** — Automated Demand Response in Commercial Buildings

New Research Projects

- **Project 4** — Establish the Value of Demand Response
- **Project 5** — Incentives and Rate Design for Efficiency and Demand Response
- **Project 6** — Demand Response Consumer Behavior Scoping Study
- **Project 7** — Demand Response C&I submetering and database